




Numi beam-line
optics study
March 14, 2005

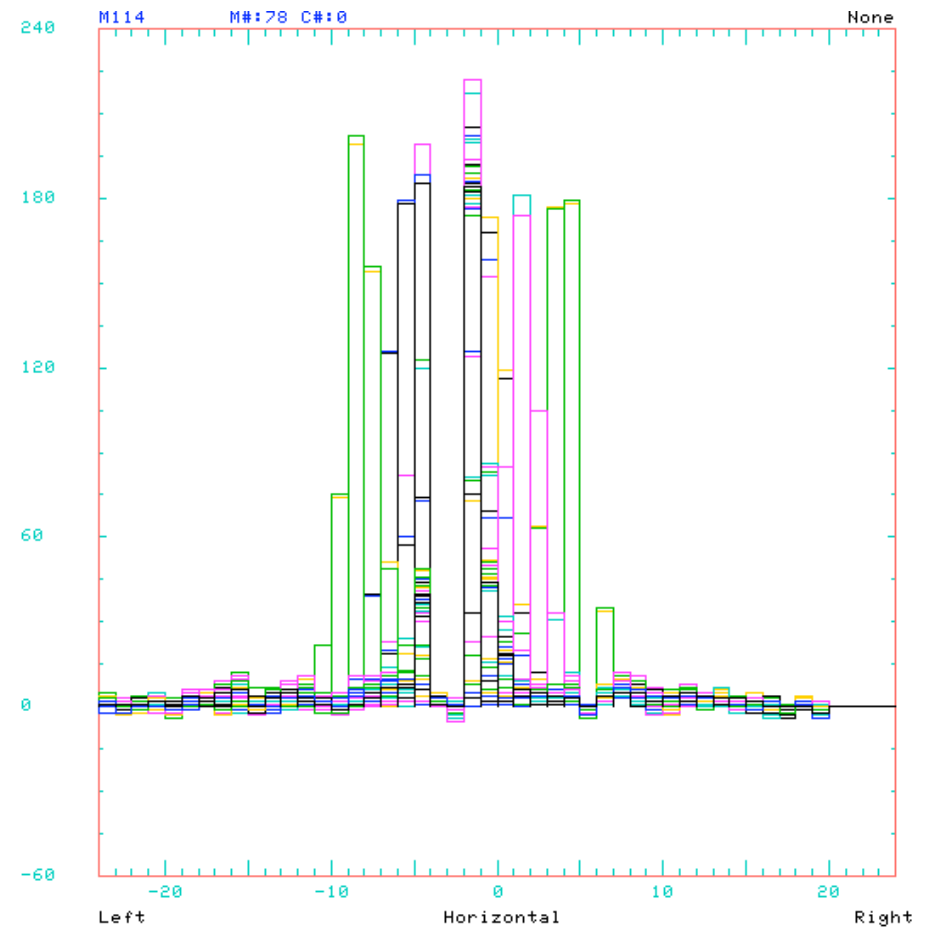
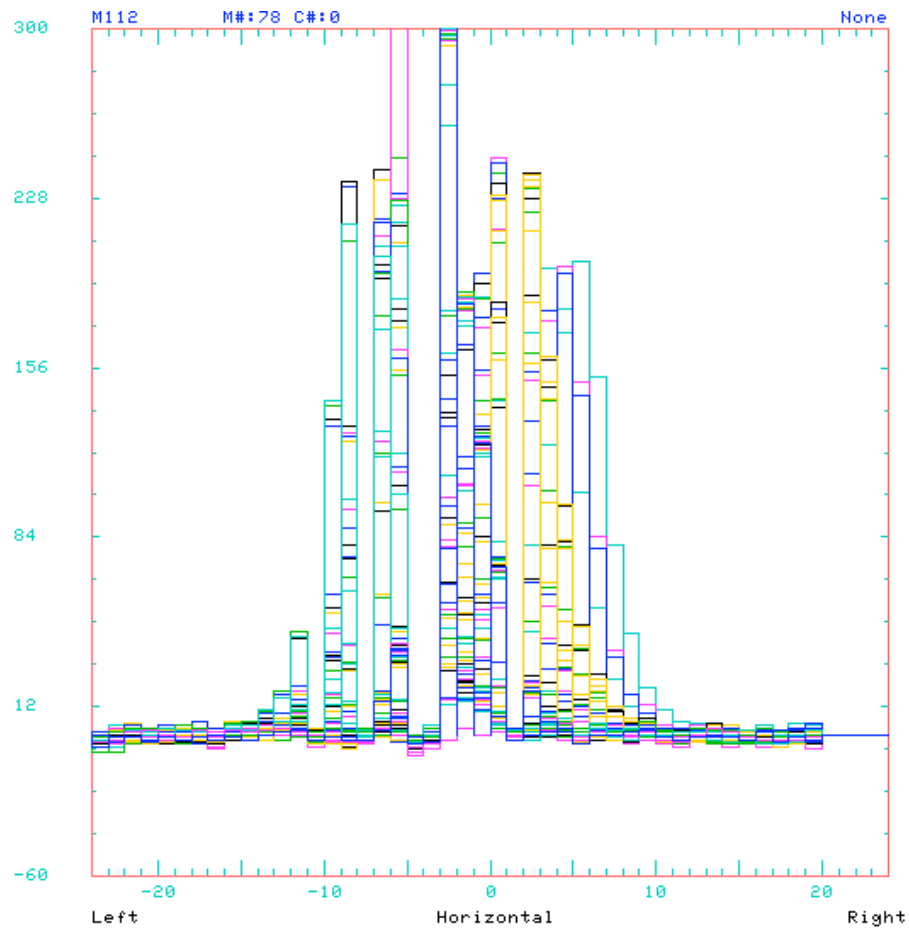
Ming-Jen Yang
Main Injector Dept.



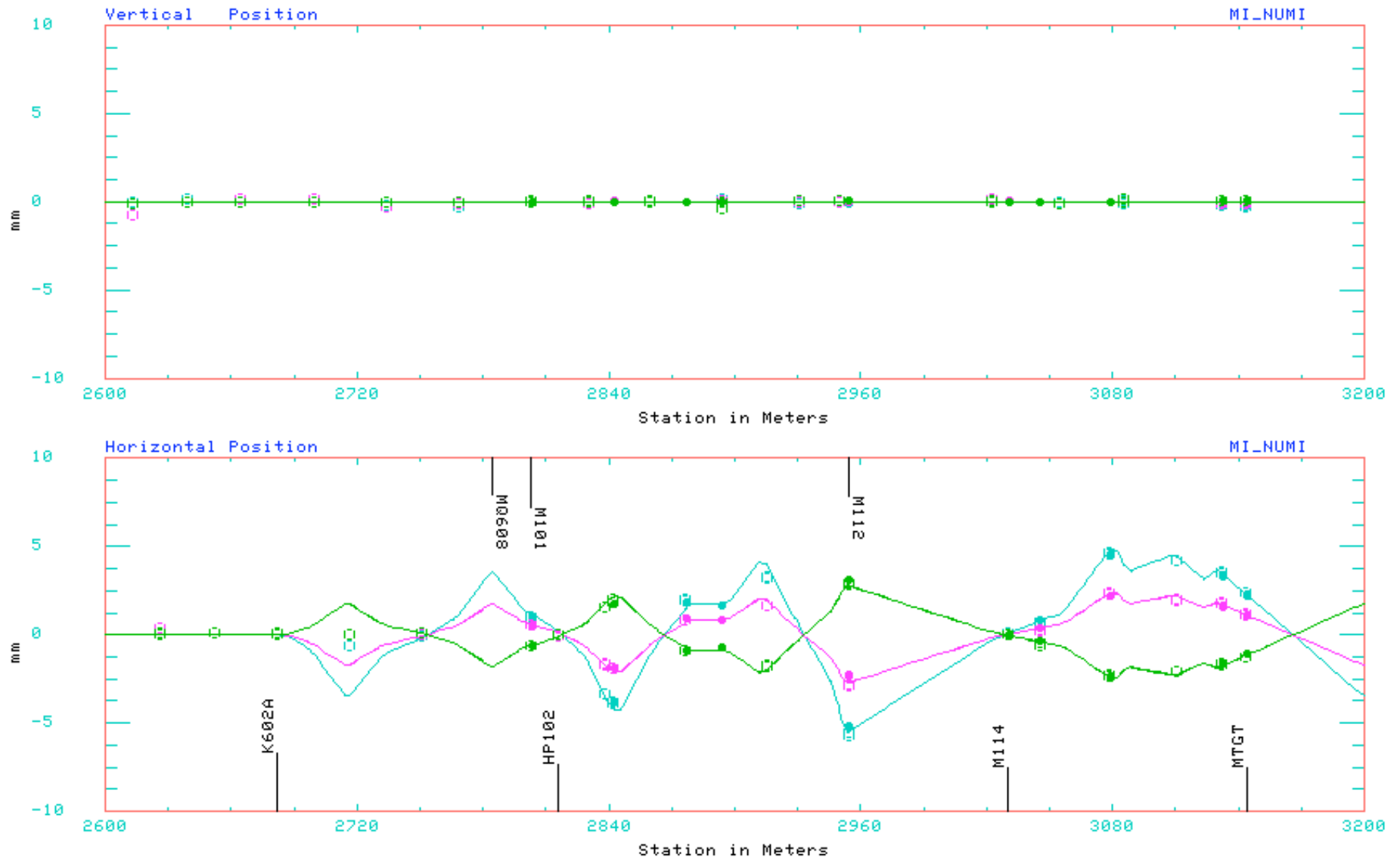
The study

- Objective
 - Optics
 - Dispersion function
- Data
 - 1-bump orbits:
 - ✓ K602A, B, & C
 - ✓ H604, extended closed bump H604/H614/H616 in MI.
 - ✓ V603, extended closed bump V603/V609/V611.
 - ✓ V605, bump V605/V611/V613.
 - Orbit with varying MI flat-top frequencies
 - ✓ -200 Hz to +300 Hz, from nominal of 53103480 Hz.

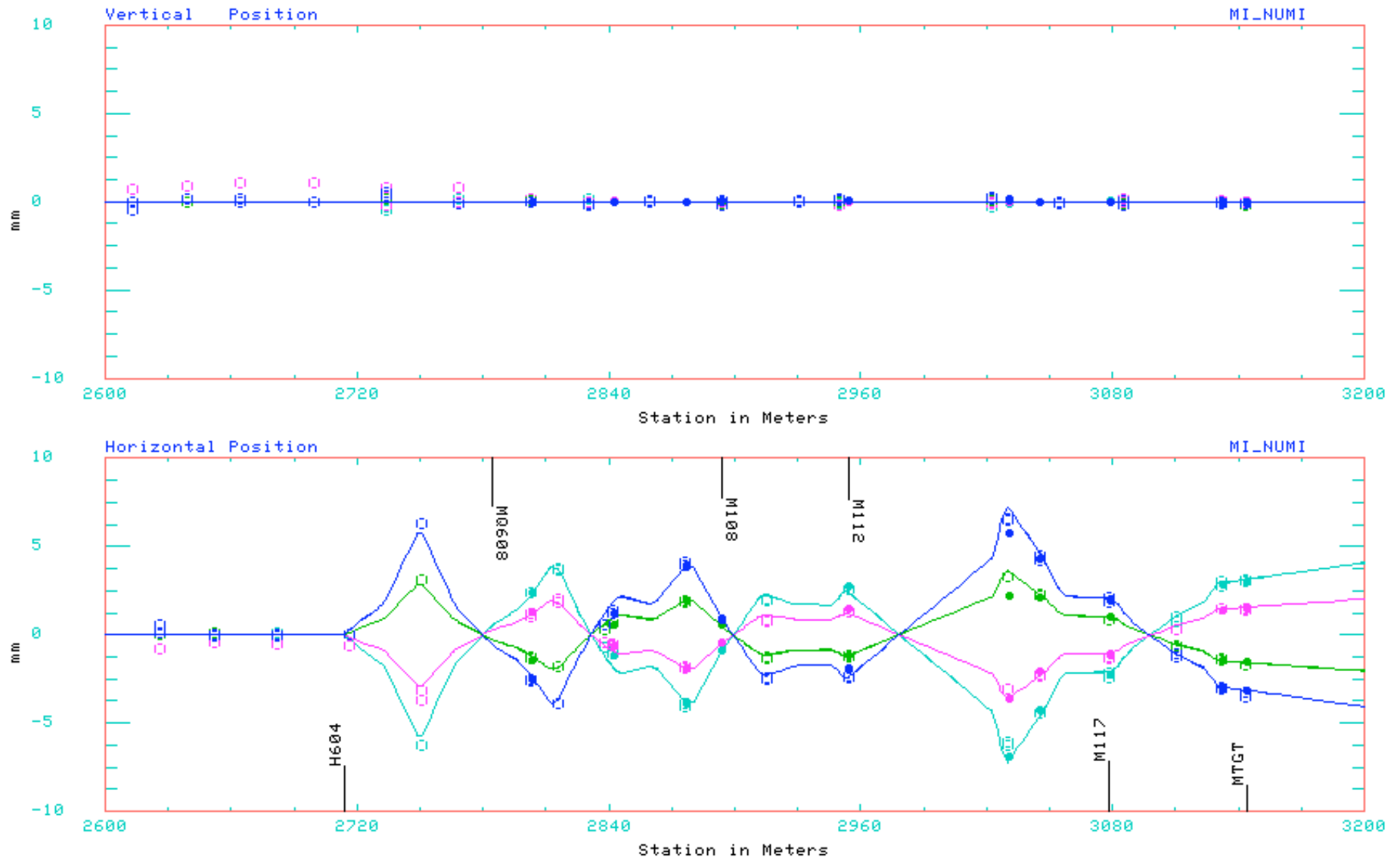
Dead wires in M112 & M114



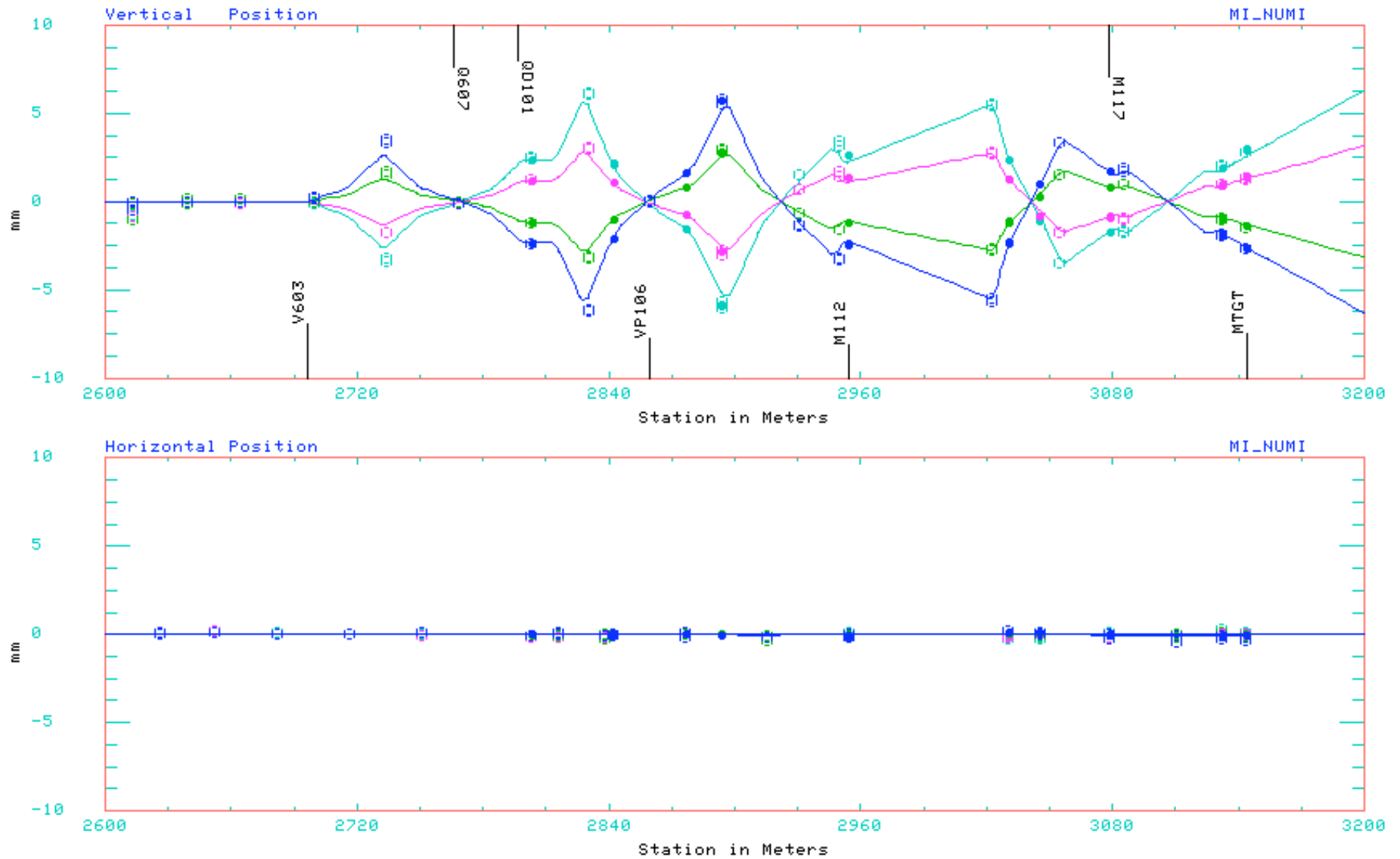
1-bump orbit with Numi kicker 602A, B,& C



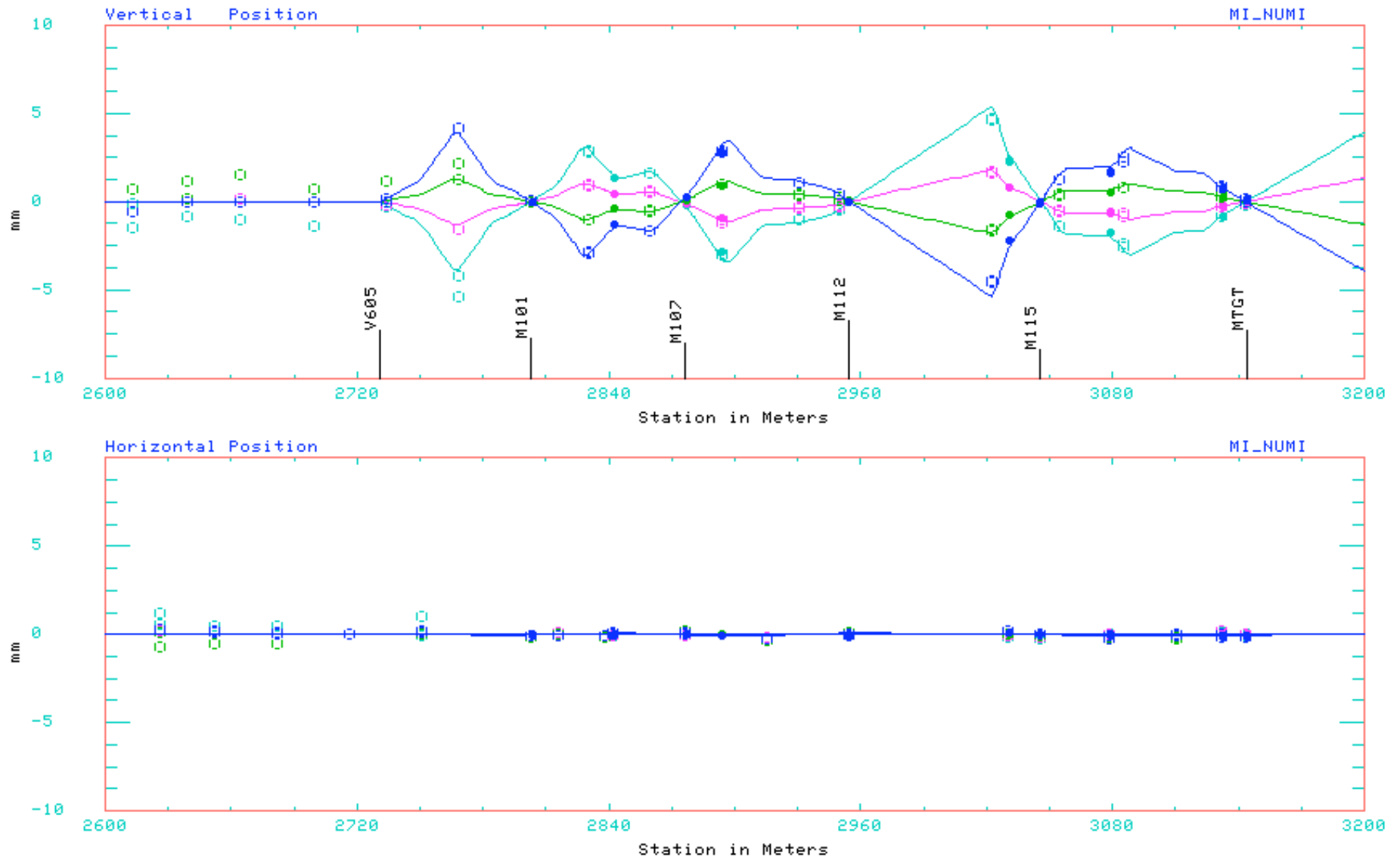
H604 1-bump orbit



V603 1-bump orbit



V605 1-bump orbit

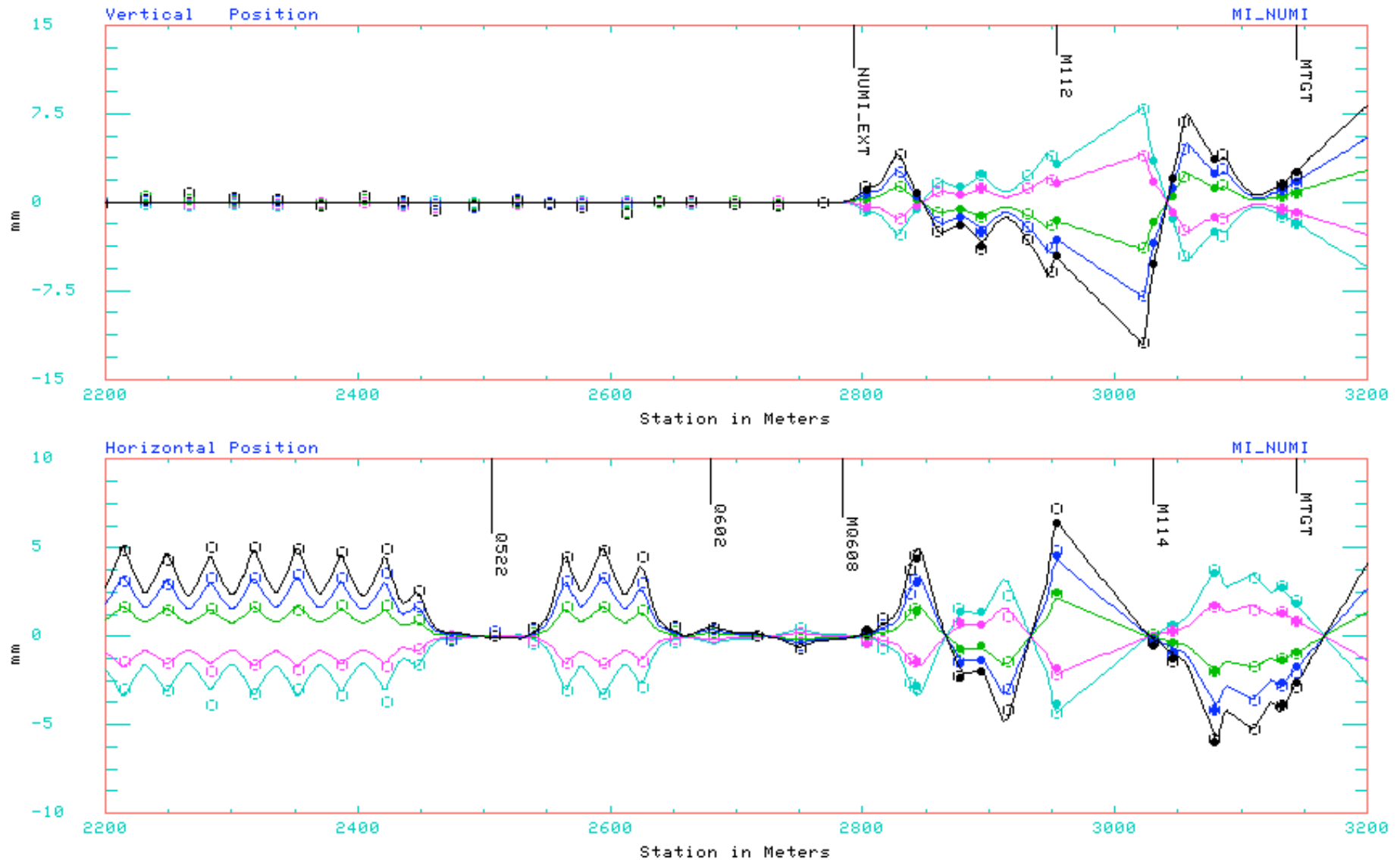


Magnet currents used in analysis

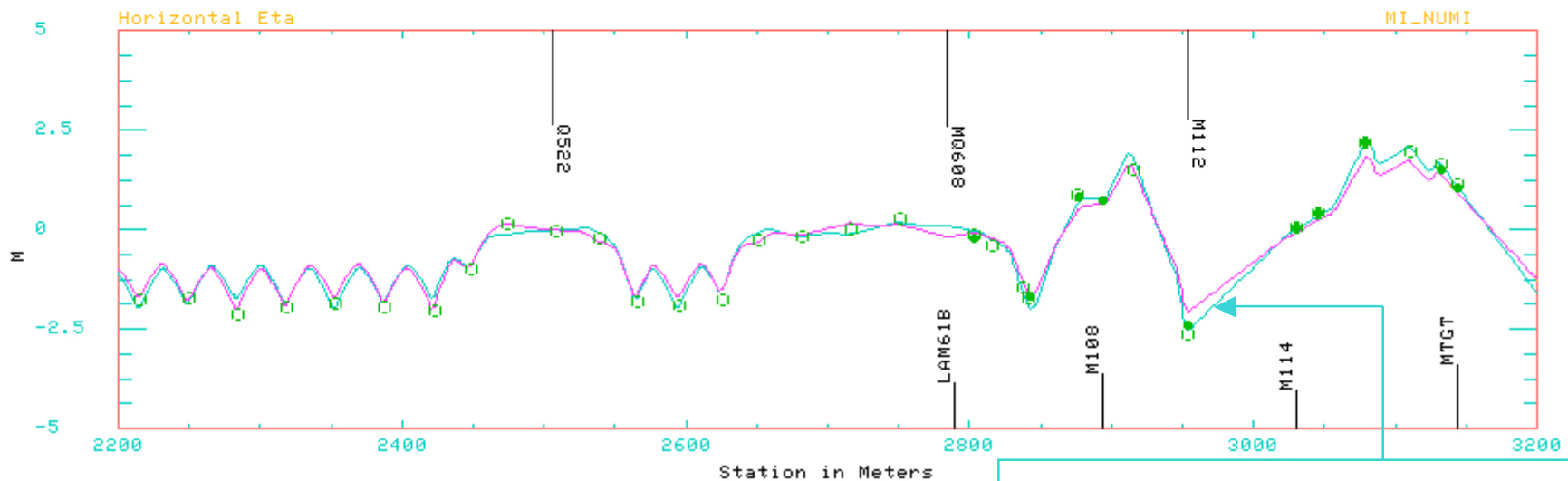
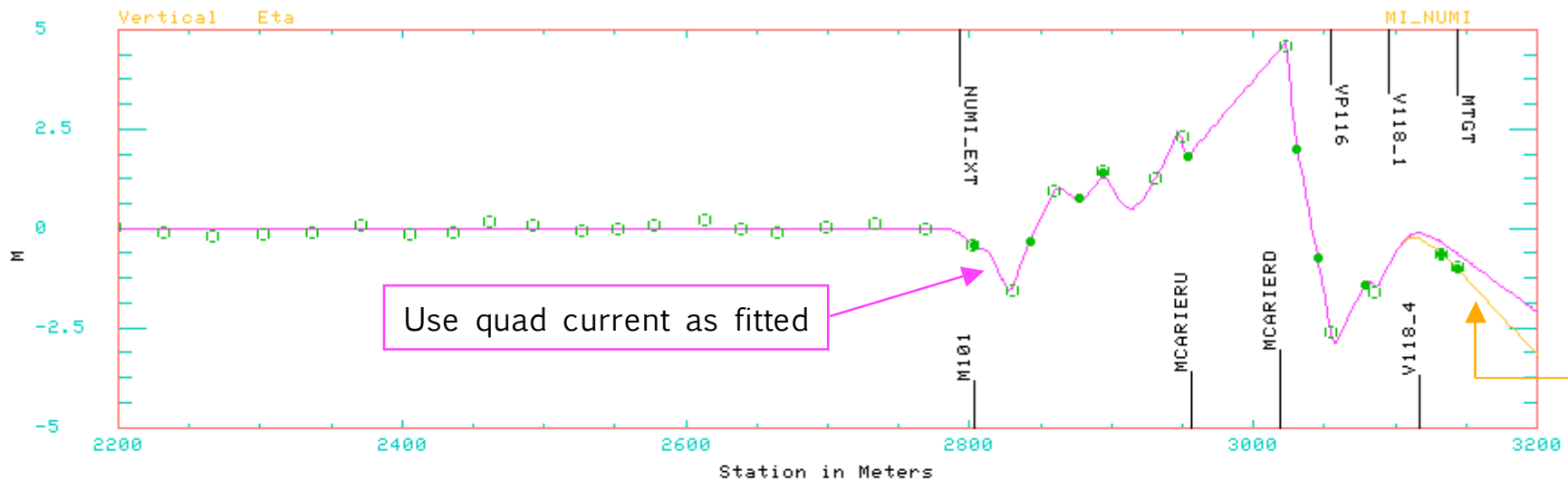
| | DB_name | Used | Read | |
|-------|---------|----------|----------|------|
| | E:V100 | 2738.495 | | Amps |
| | E:HV101 | 1600.687 | | Amps |
| | E:V108 | 4403.75 | | Amps |
| | E:H117 | 50.02187 | | Amps |
| | E:V118 | 4727.457 | 4127.457 | Amps |
| | | | | |
| QD101 | E:QD101 | 32.14375 | 56.14375 | Amps |
| QF102 | E:QF102 | 66.78438 | 64.78438 | Amps |
| QD103 | E:QD103 | 62.75938 | 63.75938 | Amps |
| QF104 | E:QF104 | 21.74688 | | Amps |
| QF105 | E:QF105 | 58.19688 | 60.19688 | Amps |
| QD106 | E:QD106 | 60.22187 | | Amps |
| QF107 | E:QF107 | 57.25 | 60.25 | Amps |
| QD108 | E:QD108 | 58.0625 | 60.0625 | Amps |
| QF109 | E:QF109 | 58.0875 | 60.0875 | Amps |
| QD110 | E:QD110 | 25.6375 | | Amps |
| QD111 | E:QD111 | 76.2375 | 78.2375 | Amps |
| QF112 | E:QF112 | 80.5125 | 82.0125 | Amps |
| QD113 | E:QD113 | 79.52187 | 81.52187 | Amps |
| QF114 | E:QF114 | 77.87187 | 78.37187 | Amps |
| QF115 | E:QF115 | 17.09687 | 25.59687 | Amps |
| QD116 | E:QD116 | 62.09688 | 64.09688 | Amps |
| QF117 | E:QF117 | 53.59687 | 55.09687 | Amps |
| QD118 | E:QD118 | 51.62188 | 51.62188 | Amps |
| QF119 | E:QF119 | 40.38438 | 35.38438 | Amps |
| QD120 | E:QD120 | 68.23438 | | Amps |
| QF121 | E:QF121 | 60.14687 | | Amps |



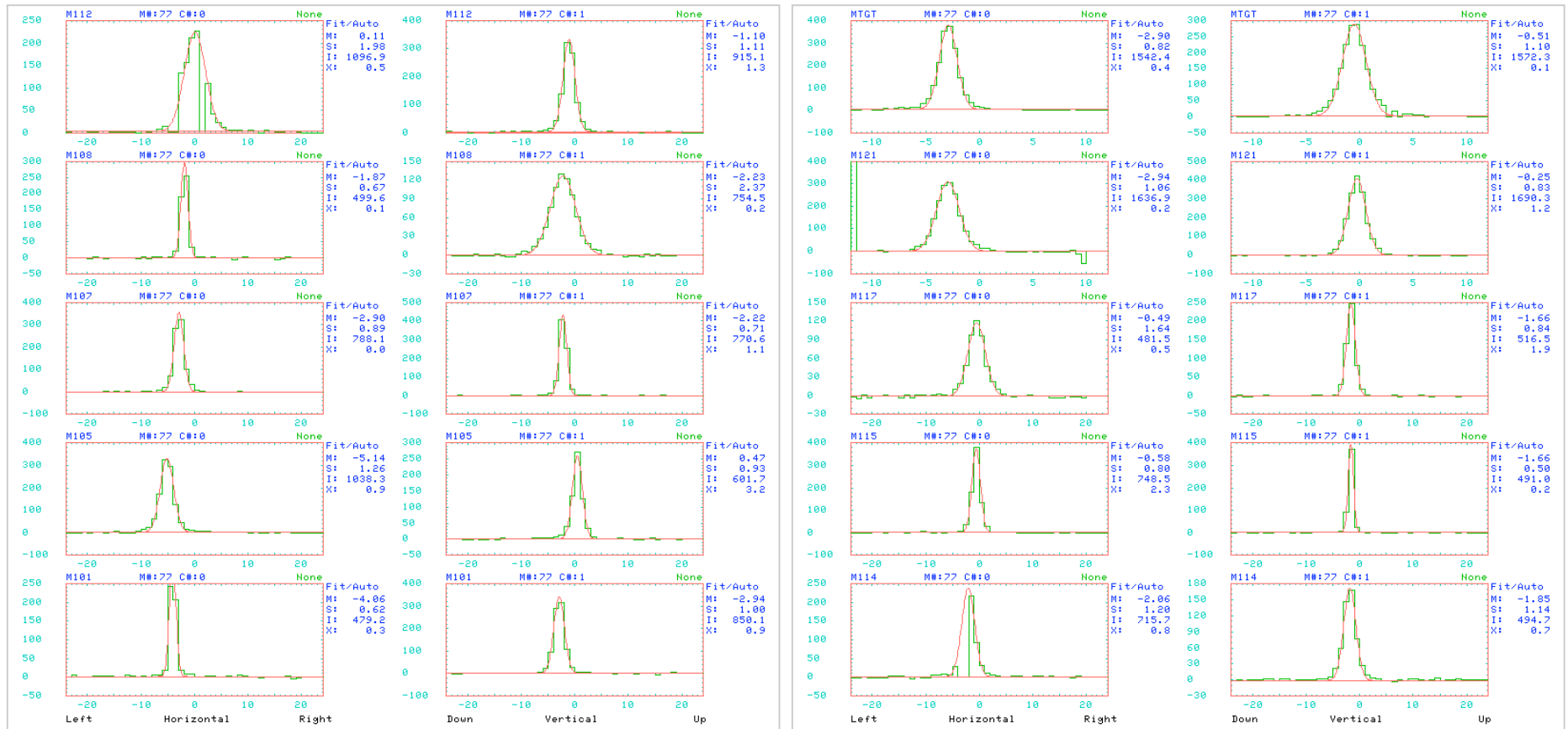
Orbits with varying MI flat-top frequencies



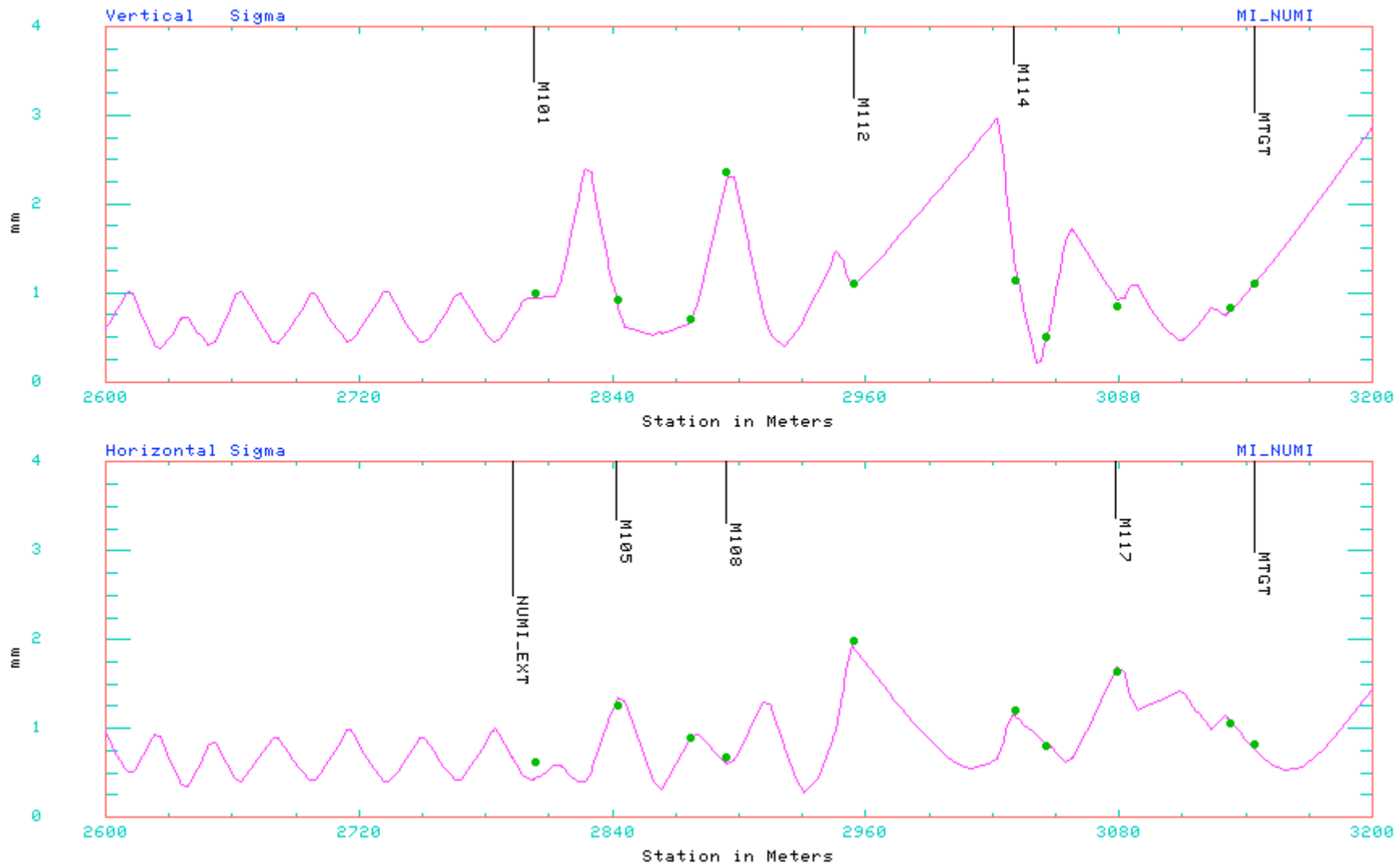
Measured dispersion function



Profiles from frame# 77



H402 3-bump 3rd order vertical orbit



Initial lattice function and fitted emittances

```

Lattice parameters
Select: [MI_NUMI      ] as [Transfer line]
Start at element: [V501      ] for [Proton      ]
*Track: [Lattice function] at ( 120      ) GeV

Lattice      Horz      Vert
Phase: ( 7.46189 ) ( 6.98339 ) 2 $\pi$ 
Beta: ( 11.927 ) ( 49.876 ) M
Alpha: ( .71416 ) (-2.14098)
eta: (-.92074 ) ( 0      ) M
etap: ( .03382 ) ( 0      )

Beam
Position: ( 0      ) ( 0      ) mm
Angle: ( 0      ) ( 0      ) mrad
Emittance: ( 2.03453 ) ( 2.31547 )  $\pi$ -mm-mrad
            $\pm$  .070644  $\pm$  .22328
SigmaP/P: ( .33046 )  $\pm$  .05895 E-3
DeltaP/P: ( 0      ) E-3

*Fit emittance: [Emitt & sig_p/p]
Momentum sigma from [Horizontal] plane

*Update [reference orbit]
Graphic window link: [GxPA 2]
*Set lattice to [Linear] order and with [Matrix]
<Exit>
```

Summary

- Data quality is good
 - Profile monitor M112 and M114
 - ✓ Both with dead wires in the horizontal plane
- Optics
 - QD101 at only 60% of design strength.
 - QF115 & QF119 are appreciably different from design.
- Dispersion function
 - Vertical dispersion near the target not understood.
 - ✓ Need to verify the V118 bend strength.
 - Horizontal good, after modifying initial condition at MI
 - ✓ To compensate the quad kick not included in calculation.
- Profile sigma
 - Matched well by calculation, except M101 horizontal.
 - ✓ Small horizontal beta and dispersions function at M101.